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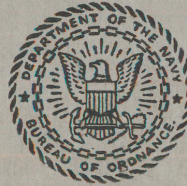
RESTRICTED

ORDNANCE PAMPHLET 1361

(PRELIMINARY)

NAPALM BOMBS

(AIRCRAFT JETTISONABLE FUEL TANKS
USED AS INCENDIARY BOMBS)



A BUREAU OF ORDNANCE PUBLICATION

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NAVY DEPARTMENT
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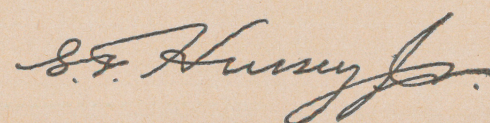
1. Ordnance Pamphlet 1361 (Preliminary) contains instructions for the preparation of Napalm bombs (aircraft jettisonable fuel tanks used as incendiary bombs).

2. Because of the urgent need for this information, it has been issued in preliminary form.* This pamphlet will be revised and issued in complete, final form as soon as practicable.

3. This pamphlet does not supersede any existing publication. The following publications contain information concerning Napalm bombs:

Ordnance Pamphlet 1315	Bombing Table for Use with Droppable Fuel Tanks
Army TBCW 21	Kit, Mixing and Transfer, Thickened Fuel, E2
Army TBCW 25	Modified Tail Fin Assembly for Fire Bomb
Army TB3-300-5	Igniters for Fire Bomb
BuAer Technical Note 64-44	
BuAer Technical Note 71-44	

4. This publication is RESTRICTED and shall be safeguarded in accordance with the security provisions of U. S. Navy Regulations, 1920, Article 76.



G. F. HUSSEY, JR.
Rear Admiral, U. S. Navy
Chief of the Bureau of Ordnance

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NAPALM BOMBS

1. PURPOSE

The purpose of this pamphlet is to disseminate the latest information on the preparation of the "Fire Bomb" (The Aircraft Jettisonable Fuel Tank when used as an Incendiary Bomb).

2. GENERAL INFORMATION

Gratifying results have been achieved from Navy and Army tests on the use of Napalm thickened gasoline as a filler for aircraft jettisonable fuel tanks. Combat reports confirm the test results and establish fuel tanks as an effective weapon, popularly known as the "Fire Bomb."

At the present time, standard Navy or Army auxiliary fuel tanks are being used. Despite the poor dropping characteristics of the tanks, accuracy in low level high-speed attack is generally achieved. Deflection error is ordinarily not a problem on low altitude releases. A detachable tail fin assembly has been designed which greatly improves the dropping characteristics of the tanks.

As an anti-personnel weapon, the fire bomb has been found to be effective against personnel in slit trenches, dugouts and foxholes. As an incendiary, the fire bomb has been found to be effective against wooden piers, wooden houses, docks and water front warehouses, wooden surface vessels and concentrations of small surface craft, ammunition dumps, truck convoys, and inflammable stores and structures both on land and water. It is also of value in burning out vegetation.

The average coverage from one bomb dropped on level terrain is approximately 100 feet by 300 feet. The longitudinal axis of the pattern is parallel to the line of flight, when the bomb is dropped from aircraft in level flight at altitudes of 100 feet and speeds of 300 knots. Higher altitudes and lower speeds decrease the coverage and, conversely, lower altitudes and

higher speeds increase the coverage. For maximum effectiveness tests have indicated that the "Fire Bombs" should be used in mass; i.e., twelve or more tanks used against a single target area in simultaneous release or with very short intervals of time between impacts.

Tests indicate that even if a fire bomb is ignited while attached to the plane, it is possible that no danger to the aircraft or pilot exists while the plane is in flight since the slipstream usually extinguishes the fire. The air arming igniters considerably reduce the possible dangers connected with the use of fire bombs aboard carriers. Pilots must jettison unused fire bombs in the open sea or other safe area before returning to a carrier if the bombs are equipped with instantaneous igniters.

3. COMPLETE ASSEMBLY

The completed fire bomb consists of the following component parts:

- (a) Aircraft Jettisonable Fuel Tanks and Stabilizers.
- (b) Igniter systems.
- (c) Incendiary filler.

These components will be discussed in the order named.

4. AIRCRAFT JETTISONABLE FUEL TANKS AND STABILIZERS

A. Fuel Tanks

There are available various types of jettisonable fuel tanks which can readily be converted into fire bombs. Illustrations of some of these tanks are shown in Figs. 1 thru 5. (For further information covering capacities and types of droppable fuel tanks, see BuAer Technical Note 64-44, dated 19 July 1944). A 150 gallon Universal or Interchangeable tank is now in production and, it is believed, will be ready for issue in the near future. This tank, shown in Fig. 5, can be mounted on the F6F (C/L), F4U-1D and 4 (Pylon). FG-1D (Pylon) and

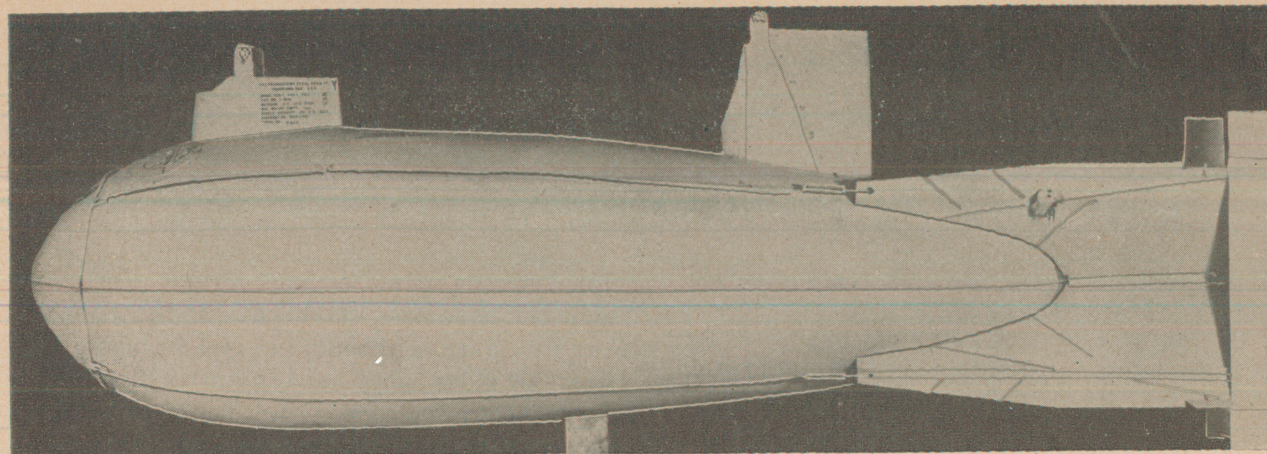


Figure 1—F4U (C/L) fuel tank with stabilizer and harness. Note clamp for igniter.

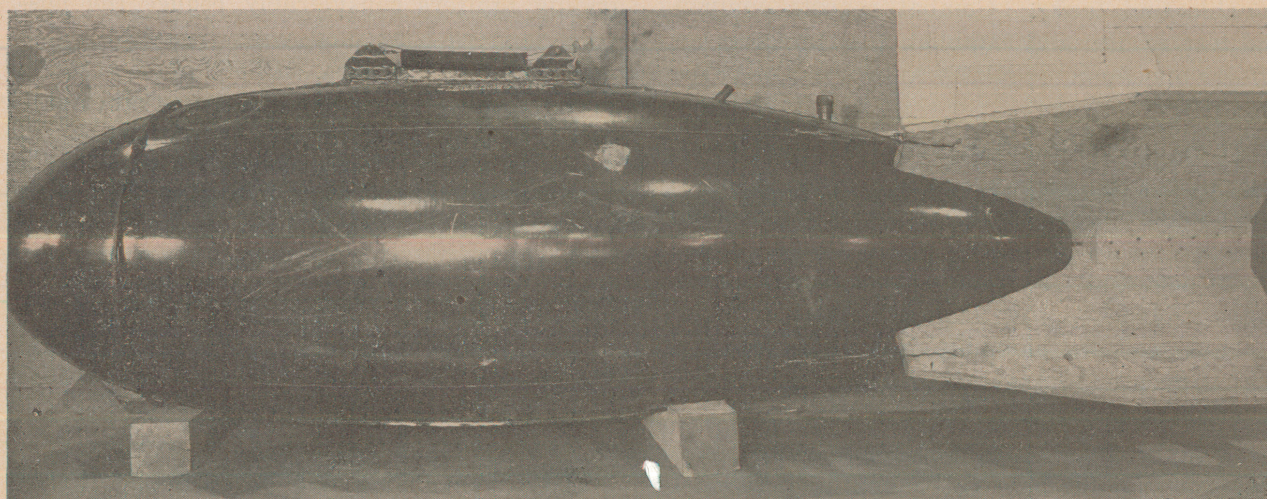


Figure 2—100-gallon droppable fuel tank with plywood tail.

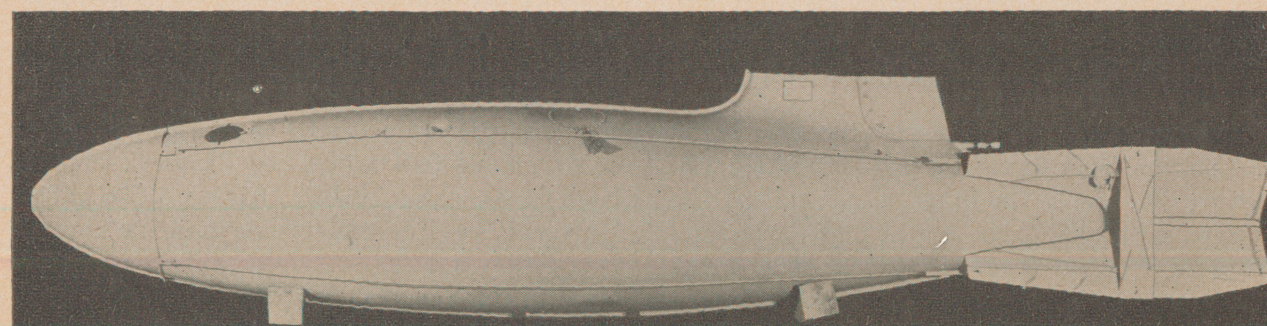


Figure 3—F6F fuselage fuel tank with stabilizer and harness. Note clamp for igniter.

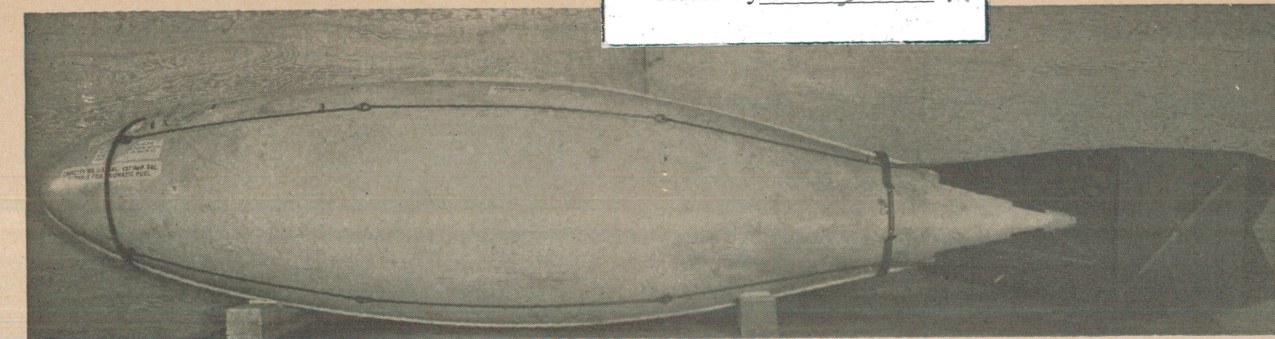


Figure 4—165-gallon F4U wing-pylon type tank.

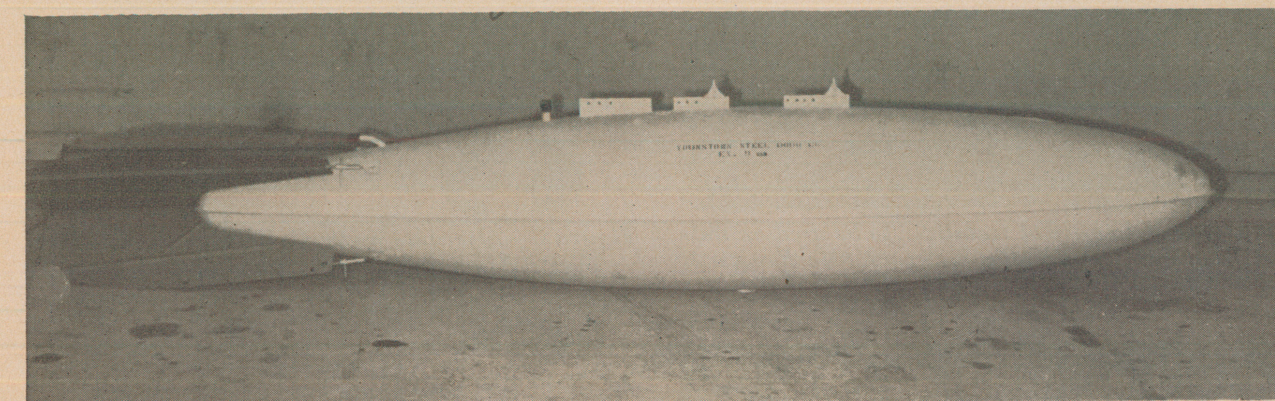


Figure 5—150-gallon universal tank.

F7F-2 (wing). It is expected that the first production of this tank will be shipped with the stabilizers in a knocked down condition to be assembled in the field; later production will be completely assembled.

B. Stabilizers

Stabilizers give the fire bomb more stable flight characteristics and enable dropping from higher altitudes. BuAer Technical Note 71-44 of 23 August 1944 gives details on the local fabrication of fin stabilizers for droppable fuel tanks. This item includes sketches, photographs, and detailed description of the methods of stabilizing the droppable fuel tanks. Briefly, a typical installation is comprised of the tail surface assembly, four cables (such as 3/32" tow target cable), safety wire for stiffening the tail surface assembly, four pins for tightening the cables after installation, and a nose ring. This assembly might be termed a "harness" since the nose ring fitted to the nose of the tank has attached to it four cables which run along the longitudinal axis of the tank, where they are attached to the tail fin assembly. Some

stabilizers are made of plywood; others of a light sheet steel. At the present time, prefabricated stabilizer kits are being produced and issued for the F4U (C/L), F6F (fuselage) and F4U-1D (Wing-pylon) tanks. (See Figs. 1, 3 and 4). These kits include stabilizers made from sheet steel shipped in the knocked-down state, together with the necessary "harness" for field installation on the fuel tank. When the Universal tank is issued, a stabilizer will also accompany it. This fuel tank has clips welded to the aft end for affixing the stabilizer, obviating the necessity for a "harness." (See Fig. 6 showing stabilizer and attachments). The stabilizers are provided with a clamp for attaching an igniter. This igniter is in addition to the fuel tank cap igniter, and further assures ignition of the gasoline gel.

In addition, the 2,000 lb. GP bomb fin has been successfully used to stabilize the tank. Two methods have been used to attach the fins. The first was to cut the fins where they were attached to the ring, slip them on the tail of the tank and weld them in place. (See Fig. 7).

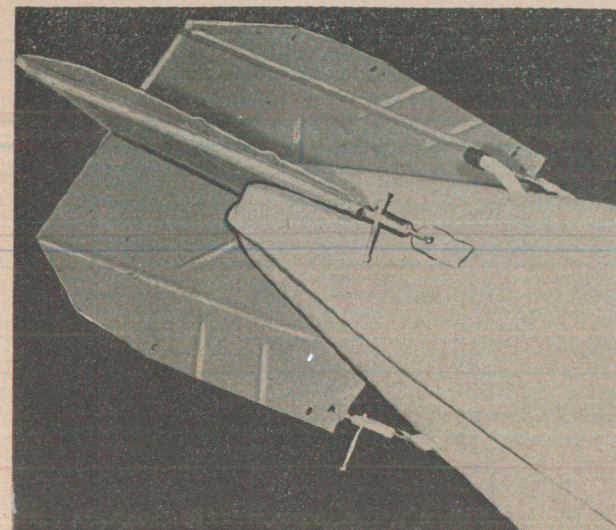


Figure 6—Close-up of stabilizer to be used on universal or interchangeable fuel tank. No harness is required on this tank as the stabilizer is attached to the tank.

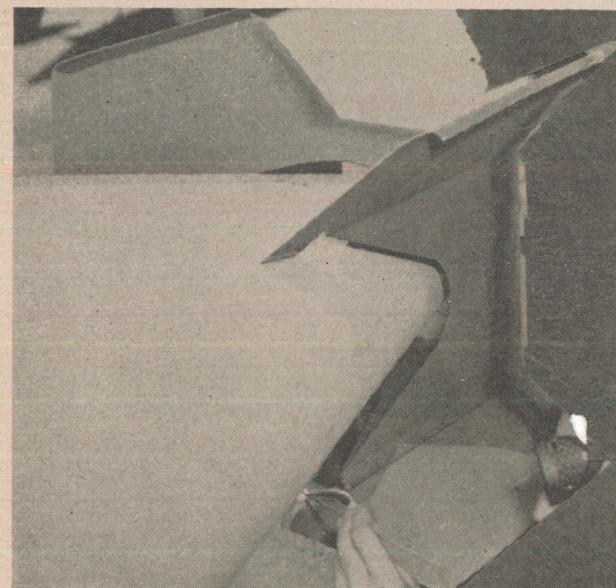


Figure 7—Method of attaching 2000-lb. GP bomb fin to the jettisonable fuel tank.

The second was to cut out the plate inside the ring and then slide the ring on to the tail of the tank and weld it in place. (See Fig. 8).

Ordnance Pamphlet No. 1315 "Bombing Table for use with Droppable Fuel Tanks" contains the sighting data necessary when dropping fin stabilized fuel tanks from F6F & F4U type aircraft when sighting is done by means of a fixed gunsight graduated in mils.

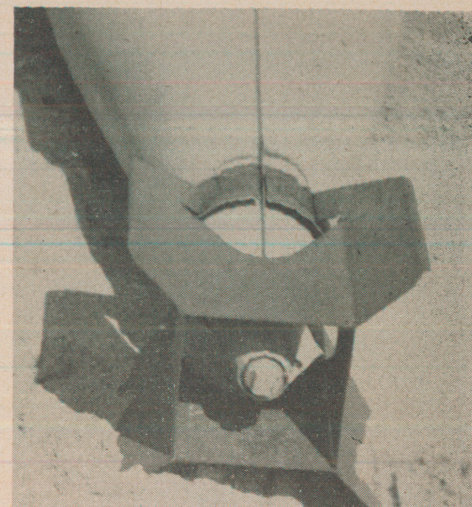


Figure 8—Alternate method of attaching the 2000-lb. GP bomb fin to the jettisonable fuel tank.

5. IGNITERS

A. Description

(1) *General.* Igniters M13 (E3R3) (See Fig. 11) M14 (E4R5) (See Fig. 12) M15 (E3R5) (See Fig. 9) M16 (E4R8) (See Fig. 10) are used with gasoline gel filled droppable gasoline tanks to convert them into "fire bombs" or incendiary bombs. The igniters are formed of white phosphorous (WP) or sodium (Na) filled M15 hand grenade bodies with special mechanical fuzes and accessories attached. Igniters M13 and M15 are designed to be attached to the outside of the tank by means of a clamp provided usually on the auxiliary tail fins. Igniters M14 and M16 have adapters that incorporate a filler cap assembly which allows the igniter to be installed in the opening provided for filling the tank. Igniters M13 and M14 use the fuze M154 (E9R17). The fuze M154 is an inertia type, jump out pin, all-ways fuze that functions on any angle of impact. It arms immediately on withdrawal of the arming wire. Igniters M15 and M16 use the fuze M157 (E9R22). The fuze M157 is an air-arming inertia type, all-ways fuze that functions on any angle of impact. It has anemometer type arming vanes. The following table shows the characteristics of the various igniters.



Figure 9—Igniter E3R5.

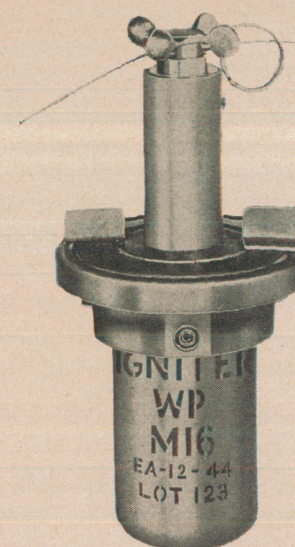


Figure 10—Igniter E4R8.

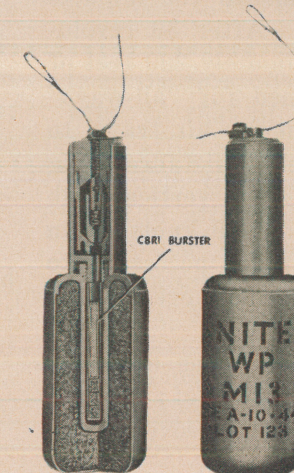


Figure 11—Igniter (WP or Na) M13 (E3R3).

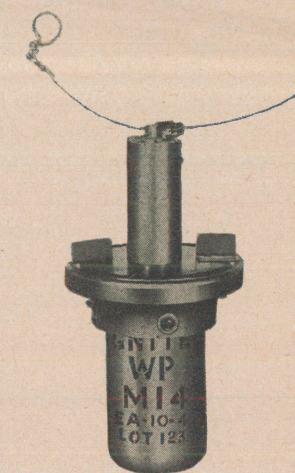


Figure 12—Igniter (WP or Na) M14 (E4R5).

(Igniters are same size but illustrations are not to same scale)

Igniter	Fuze	Method of Arming	Arming Wire	Where Attached
M13 (E3R3)	M154 (E9R17)	Jump-out Pin	C7 and C10	Outside
M14 (E4R5)	M154 (E9R17)	Jump-out Pin	C7 and C10	Filler-Cap
M15 (E3R5)	M157 (E9R22)	Anemometer Vanes	C7 and C9	Outside
M16 (E4R8)	M157 (E9R22)	Anemometer Vanes	C7 and C9	Filler-Cap

The Grenade M15 incorporated in the igniter is fitted with the bursting charge C8R1 which consists of a blasting cap C56 and 21½ grams of tetryl. The bursting charge of two earlier models E3R1 and E4R1 was of infallible powder. In all other respects these igniters are similar to the E3R3 and E4R5 listed above. On impact the fuze ignites the burster charge which bursts the grenade and scatters its contents into the gasoline gel. For drops on land, grenades with white phosphorous (WP) filler are used since white phosphorous ignites upon contact with the air. For drops on water grenades with sodium (Na) filler are used since sodium ignites on contact with water.

Igniters M13 and M14 are not safe for carrier use as they do not embody sufficient safety features. Igniters M15 and M16 require an air travel of about 150 feet to arm (See paragraph below on arming). It is believed that 150 feet

of air travel provides sufficient safety if *all arming wires are properly installed and if racks or shackles are set positively on safe.* The igniters M15 and M16 are safe for normal carrier handling and take-offs, but aircraft carrying fire bombs fitted with these igniters should not be landed aboard carriers, except in emergencies or at the discretion of commanding officers.

(2) *Arming.* The fuze M154 used in Igniters M13 and M14 does not require air travel to arm. Upon withdrawal of the arming wire a spring loaded release pin jumps out allowing a spring loaded safety pin to move into the striker body leaving the fuze armed.

The fuze M157 used in Igniters M15 and M16 is armed by rotation of its anemometer type vane. Wind flow over the igniter from any direction at right angles to the axis of the igniter will revolve the vanes. After 18 revo-

lutions of the vanes (Approximately 150 feet of air travel) the fuze is armed for impacts along the axis of the fuze. After 30 revolutions of the vanes (Approximately 220 feet of air travel) the fuze is armed for "all-ways" action. The distances given for air travel to arm the fuze apply to the actual distance along the trajectory of the tank, not vertical fall. When the tank is released at 250 knots, from horizontal flight, the air travel necessary to arm the fuze is obtained with no more than 20 feet of vertical fall.

(3) *Explosive Components.* The explosive components of the igniters consist of:

(a) *Primer M26*—Housed in sleeve assembly of the fuzes M154 and M157.

(b) *Booster*—Moisture resistant powder in a waterproof sealed cup housed in the fuze body.

(c) *Burster C8R1*—Consists of a cardboard tube containing a blasting cap C56 and 5½ grams of tetryl housed in the M15 grenade body.

B. Functioning

(1) *Igniters M13 and M14 with fuze M154*

(a) *Released to arm.* When the tank is released the arming wire is withdrawn from the fuze allowing the spring loaded release pin to jump-out, freeing the springloaded safety pin which is forced over arming the fuze. The striker body is now free to enter the sleeve on impact.

(b) *Upon Impact.* On impact the firing pin is driven into the primer no matter at what angle the igniter strikes the target. If the igniter hits directly downward the momentum of the striker body overcomes the spring driving the striker into the primer cap. On impacts on the opposite end of the igniter the striker remains stationary and the sleeve carrying the primer is forced by its momentum against the striker. On side impacts, the sleeve and the striker body are forced together by the tapered ends of the cylinder when the momentum of these components carries them against the side of the fuze body case. The flash of the primer is sufficiently strong so that regardless of the position at which the primer fires, in the

cylinder of the fuze body, the flame will ignite the Booster.

(c) *Released safe.* Even though the igniter is released safe and the fuze does not function, impact may break open the M15 grenade scattering its white phosphorous or sodium filler. This will ignite the gasoline gel just as though the burster had scattered the filler. For this reason the igniter can not be considered to be capable of being dropped "safe" with absolute assurance of non-functioning.

(2) *Igniters M15 and M16 with fuze M157*

(a) *Released to arm.* When the tank is released, the arming wire is withdrawn from the fuze, allowing the vanes to rotate. The rotation of the vanes unscrews the safety rod which falls free of the fuze. With the safety rod out of the striker body, the locking balls are free to fall inward into the space formerly occupied by this rod. The striker body is now free to enter the sleeve on impact.

(b) *Upon Impact.* The action of the fuze M157 on impact is the same as that of the fuze M154.

(c) *Released safe.* (Same as Fuze M154).

C. Safety Features

(1) *Installed in Bomb.* When the fuze M154 is assembled with an M13 or M14 igniter to a bomb it is held safe by an arming wire that holds the release pin in place. When the fuze M157 is assembled with an M15 or M16 igniter to a bomb it is held safe by an arming vane assembly that is prevented from rotating by an arming wire.

(2) *During Shipping and Stowing.* Additional safety is provided during shipping and stowage of the fuze M154 by a retaining wire and a short arming wire holding the release pin in place. During shipping and stowage of the fuze M157 the arming vanes are prevented from rotating by a safety cotter pin and a short arming wire.

D. Armed and Partially Armed Fuzes

(1) *Appearance.* If the arming wire and the retaining wire of the fuze in the M13 and M14 are missing the fuze is armed. If the anemometer vanes and safety rod have become

unscrewed any amount the igniters M15 and M16 must be considered armed.

(2) *Handling.* When armed the igniters M13, M14, M15 and M16 are extremely sensitive to any impact or blow. Extreme care should be exercised in handling armed igniters; the handling of armed igniters should be done only by specially trained personnel.

E. Installation

(1) *Instructions.* The igniters M14 and M16 are designed for installation in the filler cap opening in the tank. The igniters M13 and M15 are designed to be clamped externally to a droppable gasoline tank or tail fin assembly at any convenient point at which a suitable clamp has been provided or improvised. In cases where no clamp has been provided, the local ordnance officer must insure that the igniter is rigged in accordance with the best ordnance practice. The clamp must be installed so that the axis of the igniter is at right angles to the axis of the tank. The following general procedure will govern the installation of igniters on the tank:

(a) Remove igniter from sealed tin container and examine for any obvious physical defects. Remove fuze and burster from sealed tin container and examine for any obvious defects. Assemble igniter, fuze, and burster as directed in NavOrd. OHI A3-45. Copies of this OHI are in each packing box. Destroy any defective igniters and report all pertinent data to the Bureau of Ordnance.

(b) Install the igniter M14 or M16 by completely removing the standard filler cap and the retaining chain from the tank and replacing the cap with the igniter. After securely turning the igniter into place, loosen the set screw holding the fuze in the adaptor. Revolve the fuze until the arming wire hole lines up directly with the bomb arming control, or other point of attachment of the arming wire, so as to give a straight pull to the wire when withdrawing from fuze. Tighten the set screw to lock fuze in proper position.

(c) Install the igniter M13 and M15 so that the arming wire is given a fair lead directly to the bomb arming control, rack, shackle, or

other point of attachment. In all cases, the wire should pull straight out of the arming wire hole in the fuze.

(d) Remove the 6-inch (C7) arming wire from the fuze. To the igniter attach an arming wire, so that at least 3" extends beyond the fuze, after the arming wire swivel loop is attached to the bomb arming control or other point of attachment. Use an army C9 (6½" long 0.064" dia. brass) or Navy Mk 1 (0.064" dia. phosphor bronze) arming wire with the Igniters M15 and M16. Use an Army C10 (6½" long 0.036" dia. brass) or Navy Mk 3 arming wire with the igniters M13 and M14. If the Arming Wire C10 is not available leave the 6 inch Arming Wire C7 in place and attach the Navy Arming Wire Mk 1 to the loop of the Arming Wire C7.

(e) Attach two (2) safety clips (Fahnestock clips) over the arming wire and push snugly against the fuze.

(f) Remove the retaining wire or safety cotter pin.

(g) Should it be necessary to remove the igniter, repeat the above steps in reverse order and return the igniter to its container, sealing the open joint with tape to aid in preventing the entrance of moisture.

(2) *Points to Check*

(a) Insure that the clamp is securely and properly located and filler cap igniter is securely installed.

(b) Inspect outward appearance of igniter for obvious defects.

(c) Inspect arming wire for proper installation.

(d) See that the safety cotter pin, or retaining wire, is removed.

F. Servicing

(1) *Use of Lubricants.* No use of lubricants is required or authorized.

(2) *Igniters Exposed to Weather.* Wherever possible, new igniters from freshly opened cans should be used for best results. Exposure to weather may hamper arming of the M15 and M16 igniters by corroding the fine arming threads. Exposure to moisture will affect the

reliable functioning of the firing and bursting components of any of the igniters.

(3) *Reports of Malfunctioning.* Reports of malfunctioning and trouble encountered with these igniters should be reported to the Bureau of Ordnance. The report should contain the designation and lot number of the igniter and all data pertinent to the installation and circumstances connected with the malfunctioning together with suggested remedies.

(4) *Disassembly.* No disassembly of this igniter is authorized.

G. Packing and Marking

(1) Sixteen (16) igniters without fuze and burster are packed in a wooden packing box, with individual igniters in hermetically sealed tear-strip cans. The igniter packing box also contains instructions for assembly of igniters, instructions for installation and use of igniters, and arming wires.

(a) The packing box for igniters is marked:

16—IGNITER, (*), + (EXPLOSIVE TYPE) (A)
W/O Fuze and Burster
Lot No. _____
Weight _____
Cube _____
* WP or Na
+ M13 — (A) E3R3
+ M15 — (A) E3R5
+ M14 — (A) E4R5
+ M16 — (A) E4R8

(2) Fifty fuzes and bursters are packed in a wooden packing box. One fuze and one burster are packed in an hermetically sealed tin can.

(a) The packing box for the fuzes and bursters is marked:

50—Fuze, Bomb, { M157 (E9R22)
 M154 (E9R17)
50—Burster, C8R1
For Igniter, Incendiary Gas Tank,
M15 and M16
Lot No. _____
Weight _____
Cube _____

(3) In the past the igniters were packed 20 igniters of one type per metal lined shipping box. The fuzes were marked Igniter, Incendiary, Gasoline Tank E4R5 (or as applicable), WP (or NA). The shipping boxes were marked: "Igniter, Incendiary, Gasoline Tank, E4R5 (or as applicable), Explosive Type, W-air arming Fuze E9R22 (or as applicable).

H. Stowage

(1) White Phosphorous (WP) igniters and Sodium (Na) igniters should not be stowed in the same or adjacent compartments on ships or magazines ashore. This is necessary because of the different fire fighting techniques employed in combating sodium and white phosphorous fires. Both types should be stowed topside. Fuzes should be stowed in fuze lockers.

I. CHART OF COMPONENTS IN IGNITERS

E3R1 Series (Explosive Igniter) External (Without Filler Cap)

MODEL	FUZE	BURSTER	ARMING WIRE	GRENADE	ADAPTER	FILLING
E3R1	E9R17	Infallible Powder	C6	M-15	Middleton & Meade	WP or Na
E3R2	E9R17	C8	C6	M-15	Middleton & Meade	WP or Na
E3R3 (M13)	E9R17	C8R1	C7 and C10	M-15	Middleton & Meade	WP or Na
E3R4	E9R20	C8R1	C7 and C9	M-15	Middleton & Meade	WP or Na
E3R5 (M15)	E9R22	C8R1	C7 and C9	M-15	Middleton & Meade	WP or Na

E4R1 Series (Explosive Igniter) Internal (Filler Cap)

MODEL	FUZE	BURSTER	ARMING WIRE	GRENADE	ADAPTER	FILLING
E4R1	E9R17	Infallible Powder	C6	M-15	Middleton & Meade	WP or Na
E4R2	E9R17	Infallible Powder	C6	M-15	Eaton Tank Cap	WP or Na
E4R3	E9R17	C8	C6	M-15	Eaton Tank Cap	WP or Na
E4R4	E9R17	C8	C6	M-15	Middleton & Meade	WP or Na
E4R5 (M14)	E9R17	C8R1	C7 and C10	M-15	Eaton Cap	WP or Na
E4R6	E9R17	C8R1	C7 and C10	M-15	Middleton & Meade	WP or Na
E4R7	E9R20	C8R1	C7 and C9	M-15	Eaton Cap	WP or Na
E4R8 (M16)	E9R22	C8R1	C7 and C9	M-15	Eaton Cap	WP or Na

Bursters

1. Infallible Powder burster is made of propellant powder.
2. C8 burster is a single DuPont C56 blasting cap.
3. C8R1 burster is a DuPont C56 blasting cap and two and a half grams of Tetryl.

Fuzes

1. E9R17 fuze is all-ways, jump out pin arming (instantaneous).
2. E9R20 fuze is all-ways, aneomometer arming (converted from E9R17).
3. E9R22 fuze is all-ways, aneomometer arming (improved E9R20).

Arming Wires

1. C6 Arming Wire is .036" dia. 4' long.
2. C7 Arming Wire is .036" dia. 6" long.
3. C9 Arming Wire is .064" dia. 6½' long (safe dia. as Navy Mk. 1).
4. C10 Arming Wire is .036" dia. 6½' long.

Adapters

The Middleton and Meade Tank Cap is a standard filler cap modified for use as an igniter. The Eaton cap is a cap especially designed for the purpose.

6. FIRE BOMB FILLER

The preferred filler for use in the Fire Bomb is a mixture of 94%± ½% by weight, of gasoline gelled with 6%± ½% Napalm thickener.

U. S. Navy Napalm Thickener Type 1 is a finely ground Napalm (not more than 5% remaining on a #20 U. S. standard screen) to which an anti-caking agent has been added. This type of Napalm has been developed specifically for use in the Incendiary Mixer Mk 1 and Mods.

Napalm Thickener Types A, B and C are relatively coarse white powders (sometimes darkened by impurities).

Napalm thickeners gel the gasoline to a rubbery mass of such a consistency that when used

in the fire bomb the resulting conflagration has effective area coverage, intensity and duration.

U. S. Navy Napalm Thickener Type 1 is at present shipped in 60 lb. containers 15½" x 24½" long.

Napalm has a tendency to absorb moisture when exposed to the air for an appreciable period of time and is thereby rendered unfit for use. Therefore, unused open containers of Napalm should be disposed of, and if filling operations are conducted in the rain, provision should be made for covering the Napalm. 6%± ½% by weight of Napalm in the gasoline Napalm mix is recommended for most satisfactory results. It has been found that a thinner mix than this results in "fire ball," which is a large flame in the air with a minimum of burn-

ing on the ground. A heavier mix is equally unsatisfactory, since too thick a mix will result in ineffective coverage and slow burning of low intensity, without the essential sheet of flame.

Either 100 octane or 80 octane gasoline can be used equally well. For rapid mixing, temperature of gasoline should not be under 75°F; the optimum range is 80°F to 90°F.

In addition to the gasoline Napalm mixtures, other mixtures have been tested and are listed here for use when the problems of logistics indicate the necessity for their use:

A. 1 to 1 mixture of gasoline and Diesel oil gelled with 6½% Napalm. Higher percentages of Diesel oil have been tried, but as the ignition is unreliable no higher percentage of Diesel oil is recommended. The lower the percentage of Diesel oil, the better the ignition.

B. Twenty-five per cent (25%) gasoline and seventy-five per cent (75%) Diesel oil with 0% Napalm. This gives a large flash (fireball) with little or no after burning.

C. 1 to 1 mixture of fuel oil and gasoline. This gives a flash with some after-burning.

7. NAVY METHOD OF MIXING AND TRANSFERRING GASOLINE NAPALM MIXTURES

A. General

The Navy has developed for carrier as well as land usage an Incendiary Mixer, for mixing the gasoline and Napalm in the correct proportions. This mixer has the advantages of being reasonably safe for carriers, simple and continuous in operation. The resulting mix is ready for use without a curing period because of the quick-setting type of Napalm used. There have been developed several modifications of the Incendiary Mixer, Mark 1 type. The Incendiary Mixer Mk 1 Mod 0 is being issued at present. Other modifications will be available later.

(1) *Preparation of Napalm Gels in Temperatures below 60° F.*

Gasoline and Napalm will not gel at temperatures appreciably below 60° F unless a catalytic agent is used. Excellent gels have been obtained using the Incendiary Mixer, Mark 1 type, where the gasoline temperature was as low as 14° F, by adding about 1% by weight of Xylenol (Cresol), or about one gallon to a 150 gallon droppable fuel tank.

The Xylenol, which is in a liquid form, should be gradually poured into the droppable tank at the same time the tank is being filled with a 7% Napalm-gasoline mixture, the two operations being completed simultaneously. This procedure is necessary to insure uniform mixing of the Xylenol in the gasoline-Napalm mixture. Addition of Xylenol slightly decreases the viscosity of the gel, but this effect can be offset by increasing the percentage of Napalm from the usual 6% to about 7%.

Xylenol (Cresol) is corrosive and if in contact with the eyes or skin can cause severe burns. For this reason, when handling Xylenol the eyes should be protected with goggles and the hands with oil resisting rubber gloves. Any Xylenol accidentally spilled on the skin should be immediately washed off with strong soap and water.

B. Incendiary Mixer Mk 1 Mod 0 (Stock No. 3-M-472-250)

(1) General Description

Incendiary Mixer Mk 1 Mod 0, (see Figs. 13, 14, and 15), provides a simple and rapid means of mixing Napalm and gasoline in desired proportions, and delivering the mixture to a receiving fuel tank in one continuous operation. This operation is usually performed after the receiving tank is installed on the airplane due to the difficulty of hoisting a filled droppable fuel tank.

The mixer produces the desired gel provided certain variables are controlled. The most critical of these, from the standpoint of gel quality, are the napalm-gasoline proportion, quality and texture of the Napalm, and the temperature of the gasoline. Within limits, any change in flow of Napalm through the mixer, caused by variations of Napalm texture, can be compensated for by changing the nozzles on the discharge hose of the mixer, but large changes should be effected with an improvised Napalm orifice as illustrated in Fig. 19. A method of obtaining the correct napalm-gasoline proportion is given in subparagraph (4) following. To obtain a uniform gel, it is essential that the quality of the Napalm be such that no settling will occur. The U. S. Navy Napalm Thickener Type 1 has been especially processed for use in the Incendiary Mixer Mk 1 and Mods, but it is necessary to modify the Mk 1 Mod 0 mixer as described in subparagraph (4).

Napalm takes up moisture quite rapidly. Over-exposure to the atmosphere may defeat the purpose of adding the Napalm to the gasoline by seriously interfering with the gelling process. Do not expose the Napalm to the atmosphere longer than is absolutely necessary.

(2) Installation

For shipboard use, the gasoline supply line is connected directly to the 1¼" inlet swivel connection. For land use, where the tank truck is equipped with a male 1½" hose connection, the adapter which is furnished with the

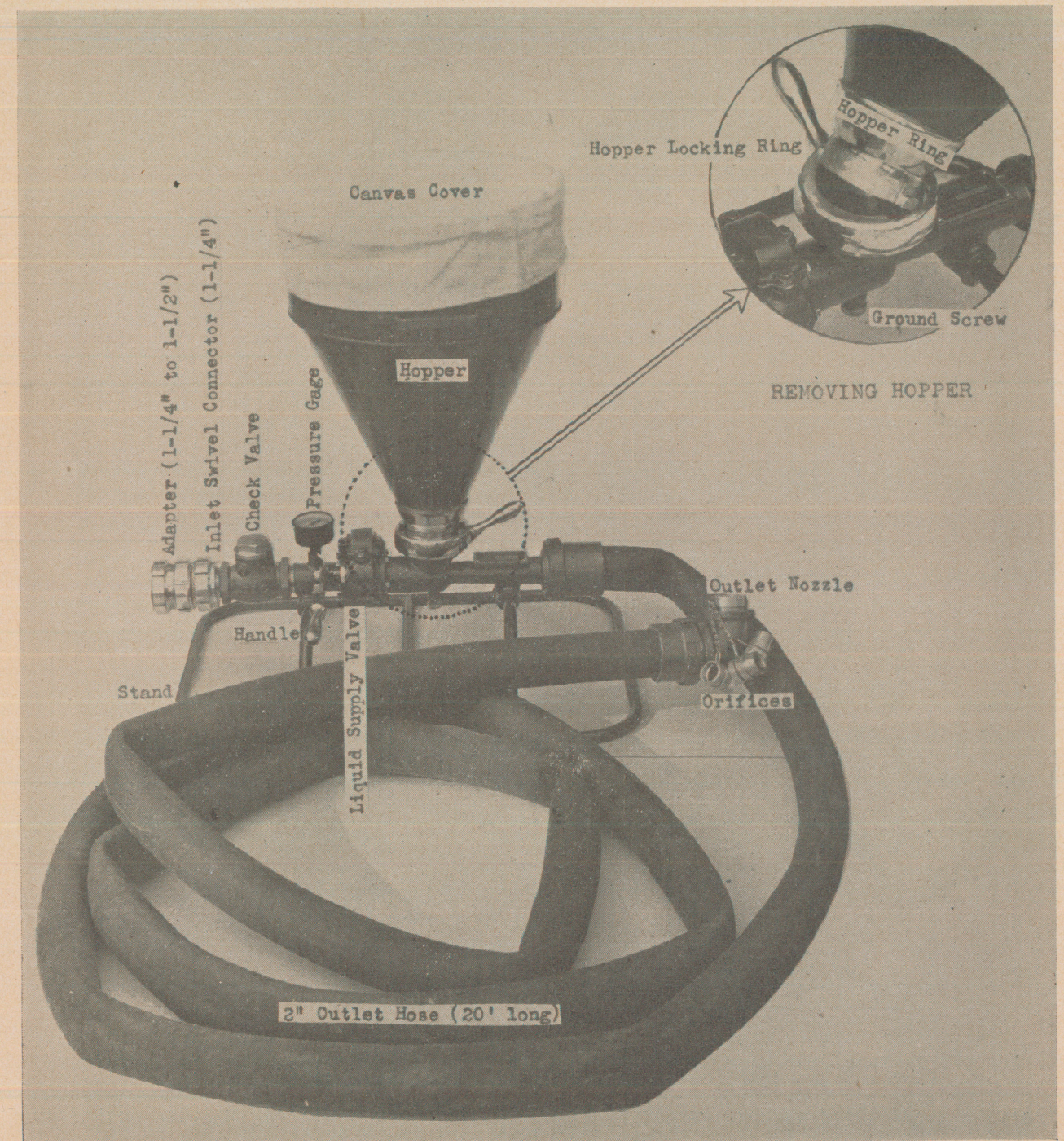


Figure 13—Incendiary Mixer Mark 1 Mod 0.

unit must be used. If the tank truck is equipped with a female hose connection, a 1½" nipple (not furnished) will also be required.

The 2" discharge hose, furnished with the unit, contains a static wire from the delivery tip to the coupling at the mixer. The container

being filled and the mixer must be grounded, and this can be accomplished by grounding only the mixer and holding the hose nozzle in contact with the container being filled. A screw connection for the ground wire is located underneath the mixer body.

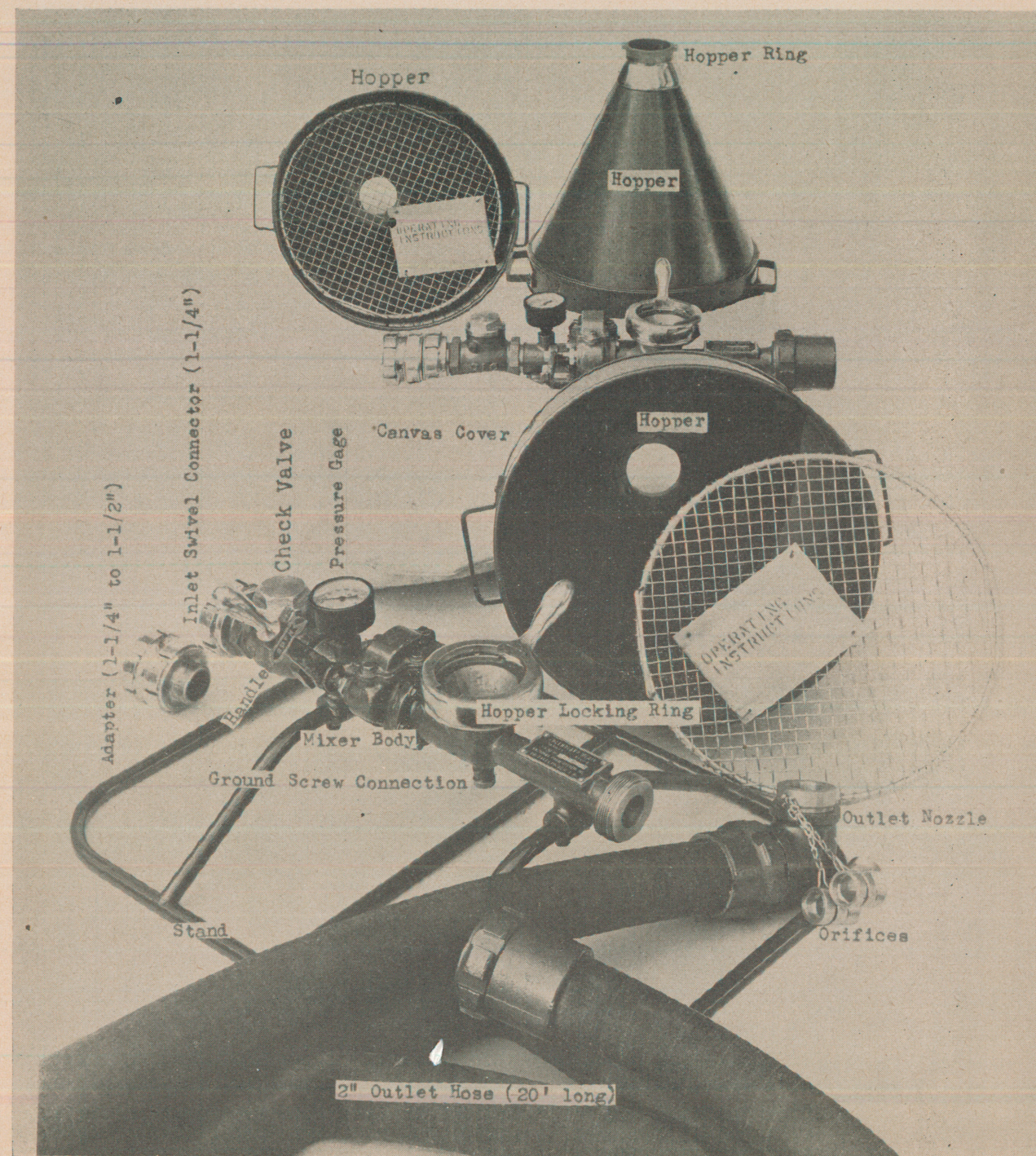


Figure 14—Two Incendiary Mixers Mark 1 Mod 0 (partly disassembled).

RESTRICTED

(3) Operating Principle

For a given gasoline temperature and a given inlet pressure on the fuel line, more Napalm will be drawn into the mixer with the larger outlet nozzle. Conversely, if the percentage of Napalm is found to be too high, it may be reduced by using a smaller outlet. Generally speaking, low pressure, high fuel temperatures and most important, coarse Napalm call for larger outlet nozzles. The 2" delivery hose on the discharge side of the mixer is fitted with four outlets (20/32"—24/32"—28/32"—30/32"). The operation of the mixer has been based on tests using inlet operating pressures of 20 to 55 lb./sq. in., and within this range the operating pressure has no marked effect on the intake percentage of Napalm. If the mixer fails to take in the desired amount of Napalm at higher

pressure by nozzle adjustment alone, a throttle valve should be inserted on the inlet side of the mixer.

The flow of gasoline varies directly as the square root of the pressure and indirectly as the square root of the specific gravity of the gasoline for a given temperature. Since any gasoline likely to be used in the mixer will have approximately the same specific gravity, the flow can be assumed to vary directly as the square root of the pressure. At 25 lbs. gauge inlet pressure at the mixer, the flow rate of the gasoline is 28 gals. per minute. It is possible to calculate the flow rate of the gasoline used at other inlet pressures from this fact. For example, if gasoline is delivered to the mixer at 16 lbs. gauge pressure, the flow rate would be $\frac{\sqrt{16}}{\sqrt{25}} \times 28$ or $\frac{4}{5} \times 28$ or 22 2/5 gals. per minute.

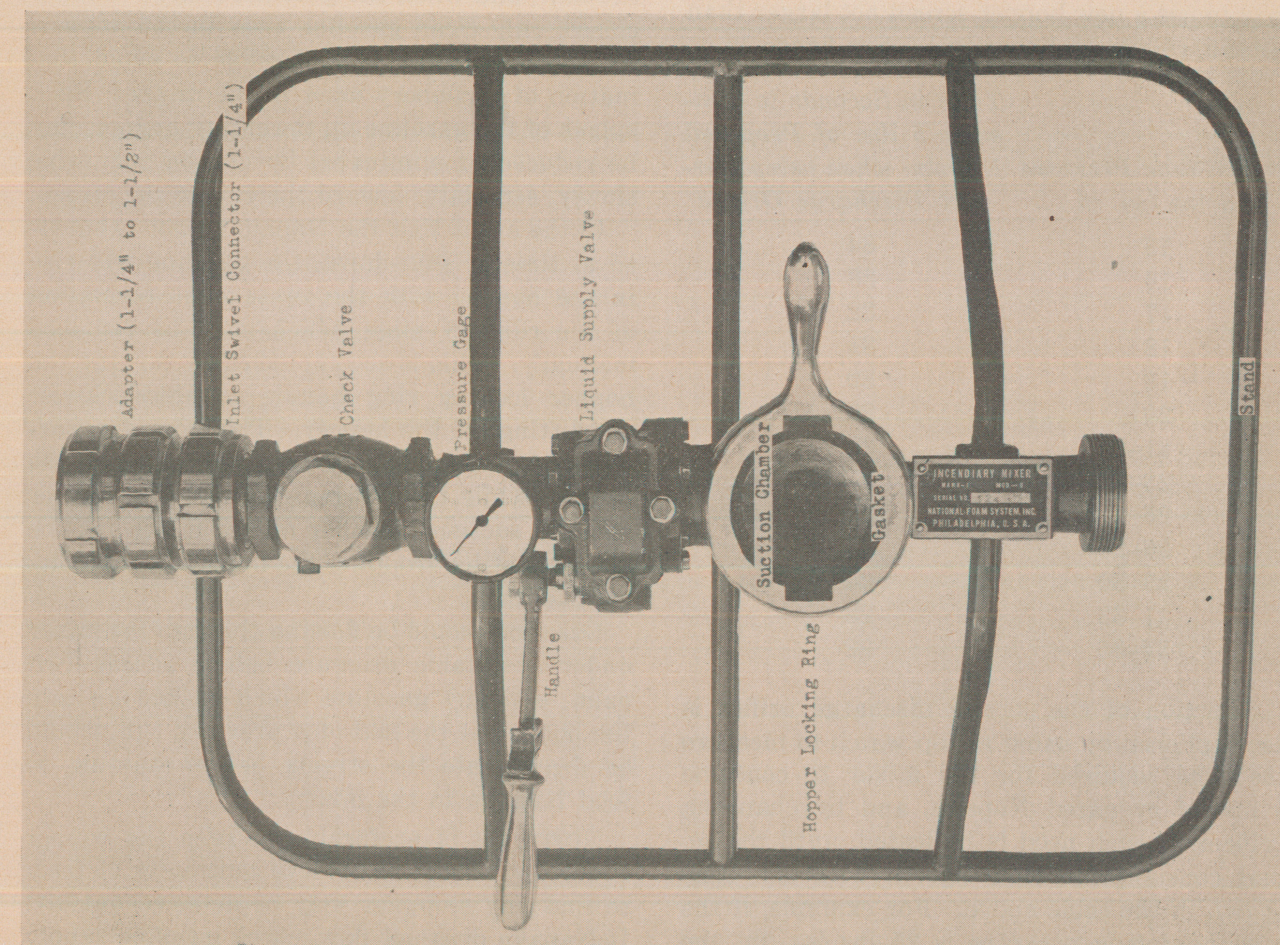


Figure 15—Top view of Incendiary Mixer Mark 1 Mod 0 (without hopper and hose).

RESTRICTED

(4) *Selection of Discharge Orifice*

Using the relationship between pressure and flow rate given above, the following table was computed for use in "trial and error" selection of the correct discharge orifice to give the desired mixture of 94% gasoline to 6% Napalm. The table is for any type of Napalm containing 6% to 7% by weight of anticaking agent (including U. S. Navy Napalm Type 1).

IMPORTANT NOTE: The very fine texture of Type 1 Napalm causes an intake of Napalm too high for reduction to the desired 6% by nozzle adjustment alone; hence, the flow of Type 1 Napalm must be further reduced by improvising an orifice from heavy cardboard, wood, or metal for insertion into the throat of the suction chamber of the mixer. (See figures 19 and 20.). A 7/16" diameter opening has been found to be satisfactory, and it is also necessary to use a new hopper screen not larger than 5-mesh (5 sqs. to linear in.). See figure 16.

Inlet Gauge Pressure in lbs./sq. in.	Time in Seconds to Con- sume 5 lbs. of Prepared Napalm when using Cor- rect Discharge Orifice
15	34
16	33
17	32
18	31
19	30
20	29
21-22	28
23-24	27
25	26
26-28	25
29-30	24
31-33	23
34-35	22

Selection of the correct discharge orifice is accomplished by using a stop watch to measure the time required for the mixer to consume 5 lbs. of prepared Napalm, and by changing orifices, if such need is indicated, until the actual consumption time agrees with the time shown in the table above. For example, if the inlet operating pressure is 25 lbs./sq. in. the correct consumption time as shown in the table

should be 26 seconds. If the measured time is more than 26 seconds, repeat the operation using the next larger orifice and, conversely, if the measured time is less, try the next smaller orifice, etc., until the consumption time is 26 sec. Samples of Napalm larger than 5 lbs. may be used in this test for more accuracy, in which case the consumption time must be proportionately increased. The tank in which consumption time tests are run can still be used as a fire bomb even though it may contain free gasoline and/or varying percentages of Napalm.

(5) *Use and Care in Handling*

Operation of the Incendiary Mixer Mk 1 Mod 0 should be such that the correct amount of Napalm ($6\pm\frac{1}{2}\%$) is entirely consumed before the receiving fuel tank is full. A few seconds run after exhaustion of Napalm serves to clean the unit, and when the gasoline shutoff valve is closed, only clean gasoline rises in the hopper. By this procedure, it is possible to avoid formation of a rubbery mass in the mixer. Back splash of the gasoline up the empty hopper may be reduced or eliminated by closing the valve slowly, especially toward the end of the stroke.

In the event that the Napalm is not exhausted at time of shut-down, the gasoline will rise in the hopper with the consequent formation of the rubbery mass which must be removed manually. This is accomplished by turning the hopper locking ring handle counterclockwise and lifting off the hopper. The loose dry particles of Napalm can be emptied back into the supply, while the reacted mass in the hopper and the suction chamber of the mixer can be disposed of by dropping the mass into a receiving fuel tank.

Gasoline should be flowing through the mixer under a suitable pressure before adding Napalm, and any gasoline which backed up into the hopper at the end of a previous run should be drawn into the stream before starting to feed Napalm to the mixer.

NOTE: It is preferable to keep the hopper about $\frac{1}{2}$ full and to observe continuity of feed, so that any stoppage may be detected quickly. If Napalm does not flow, check gasoline supply pressure and stoppages in mixer and hose.

In replacing the hopper, see that the gasket is clean and in place. The hopper is installed by turning the locking ring handle counterclockwise as far as it will go, inserting the hop-

per in the openings in the locking ring and turning the handle clockwise. The hopper must be locked securely in place to prevent air leakage, which would seriously reduce the Napalm

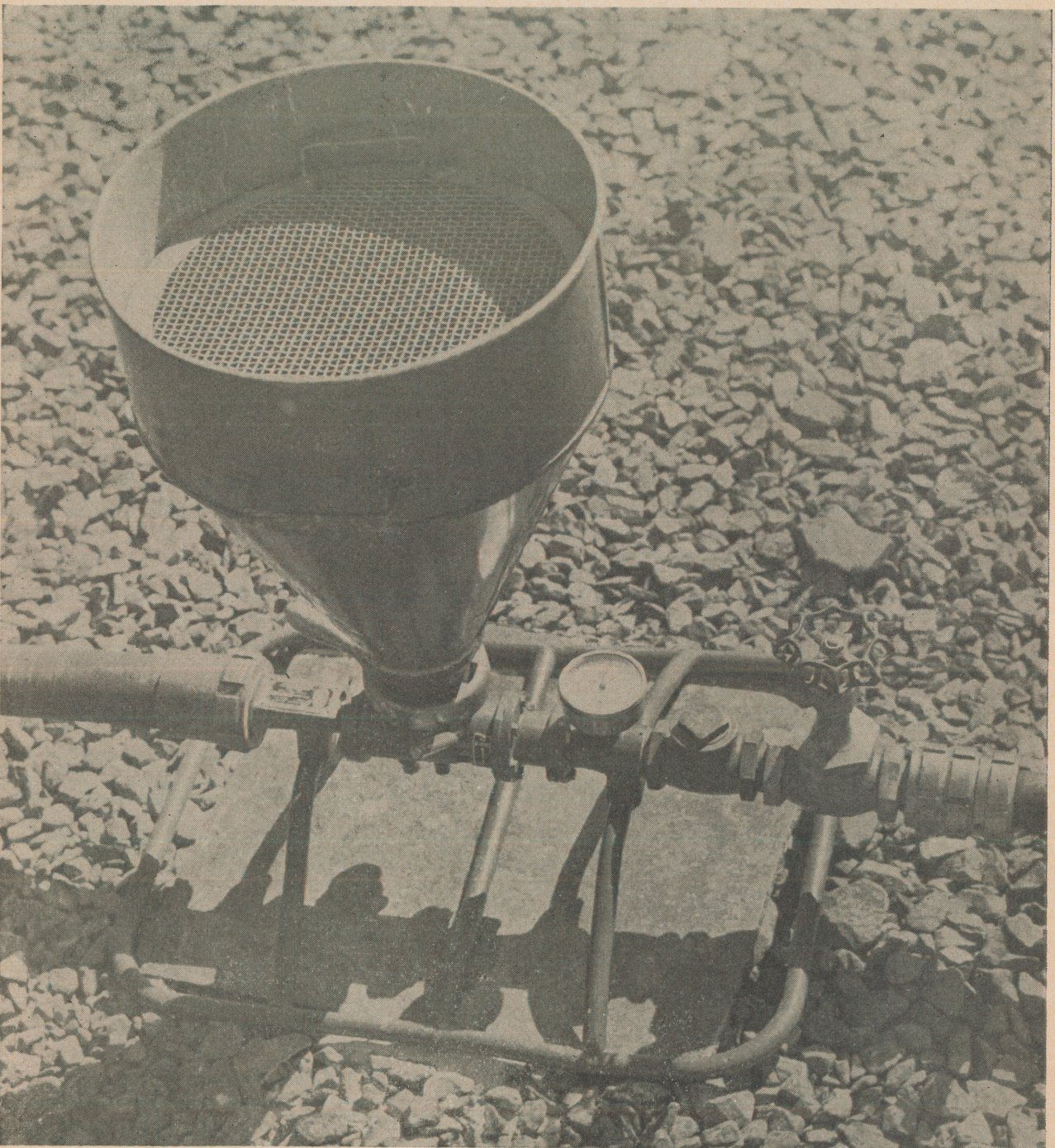


Figure 16—Incendiary Mixer Mark 1 Mod 1 (adjustable nozzle not shown). Note 5-mesh (5 sqs. per linear in.) screen in hopper. The screen is an essential part of the mixer and should always be used.

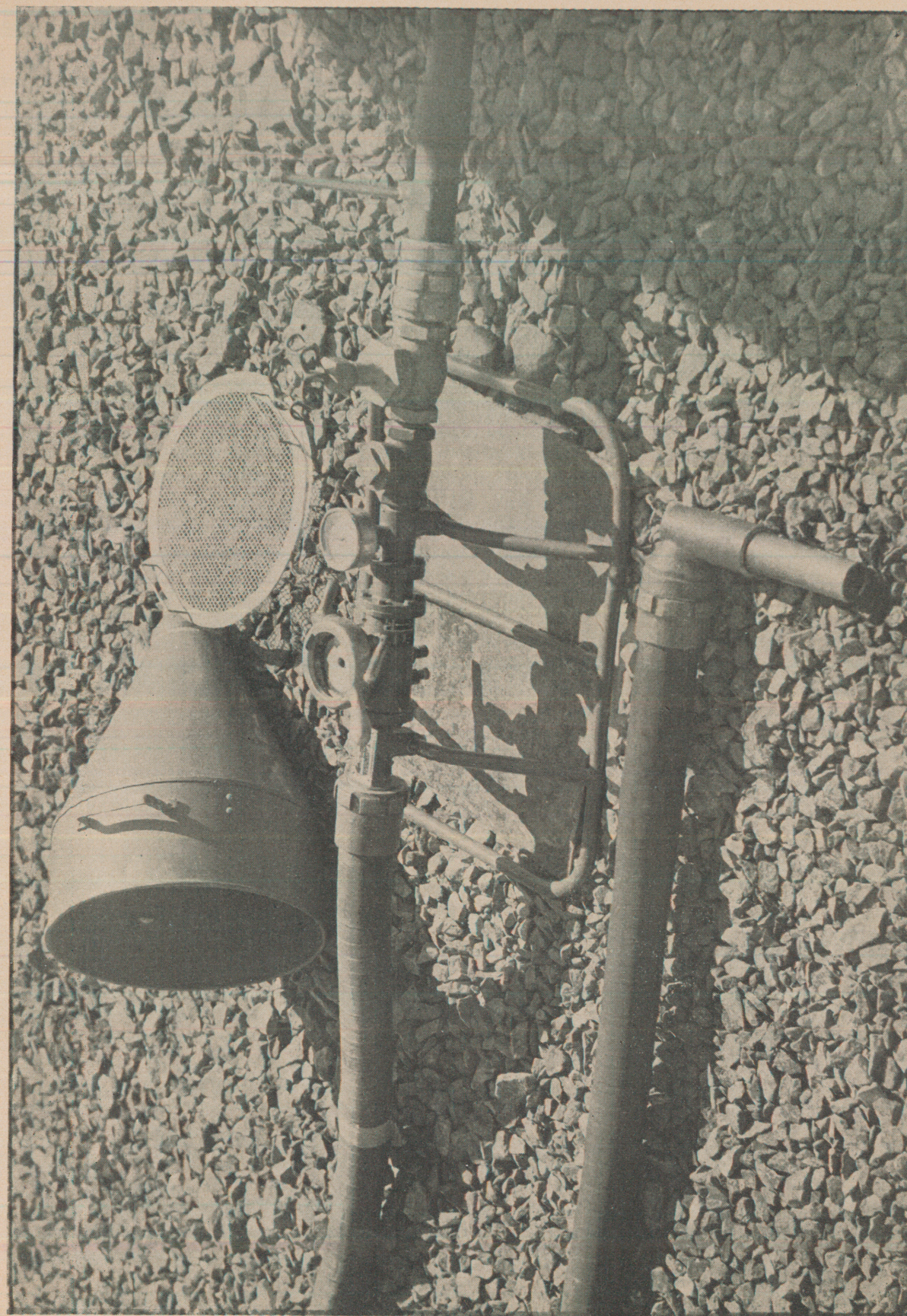


Figure 17—Incendiary Mixer Mark 1 Mod 1 (partly disassembled). Note ground connection screw and grease fitting underneath the mixer body.

intake. For the same reason, the Napalm in the hopper should not be allowed to form too deep an inverted cone which might allow air to be sucked in.

After each use, the mixer should be thoroughly cleaned and inspected. By turning the mixer body upside down, thus opening the flap check valve, and holding one end toward the light, a clear passage should be observed through the jets. If the check valve moves sluggishly, the top plug should be removed and the mechanism cleaned. It is important to inspect all valves to insure proper functioning.

C. Incendiary Mixer Mk 1 Mod 1 (Stock No. 3-M-472-260)

(1) General Description

The Incendiary Mixer, Mk 1 Mod 1 (See figures 16 to 22 inclusive) has the following characteristics, different from those of the Incendiary Mixer Mk 1 Mod 0 which it will replace: (1) In the Mk 1 Mod 1 a Napalm shut-off valve is incorporated in the mixer body; (2) an adjustable calibrated nozzle replaces the four orifices or outlets; (3) a throttle valve replaces the quick-operating gate valve; (4) an orifice is added in the throat of the suction chamber to

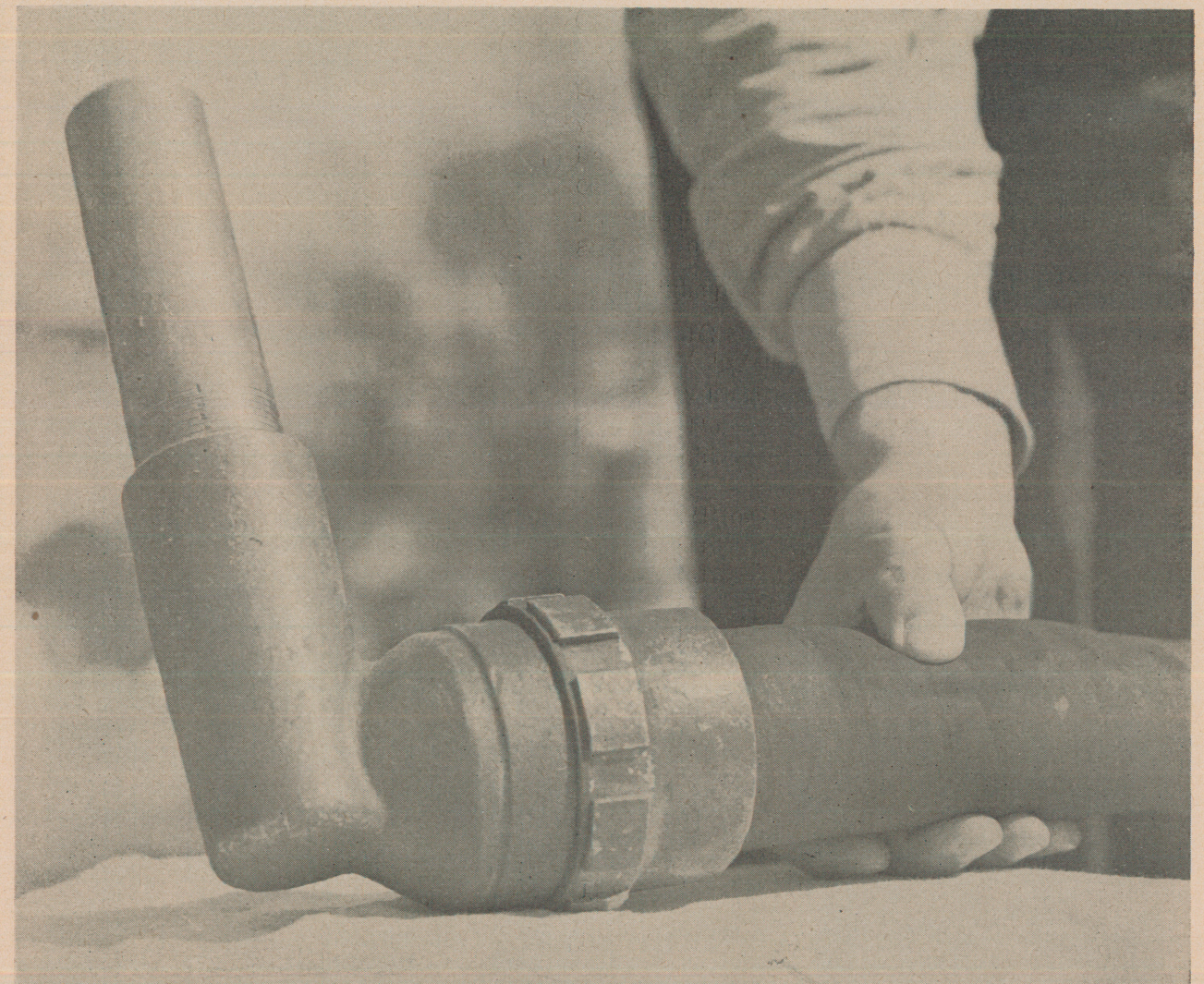


Figure 18—Adjustable nozzle for Incendiary Mixer Mark 1 Mod 1. Note calibrations. The desired $6 \pm \frac{1}{2}\%$ intake of Type 1 Napalm is usually attained by setting the nozzle on or slightly below "4".

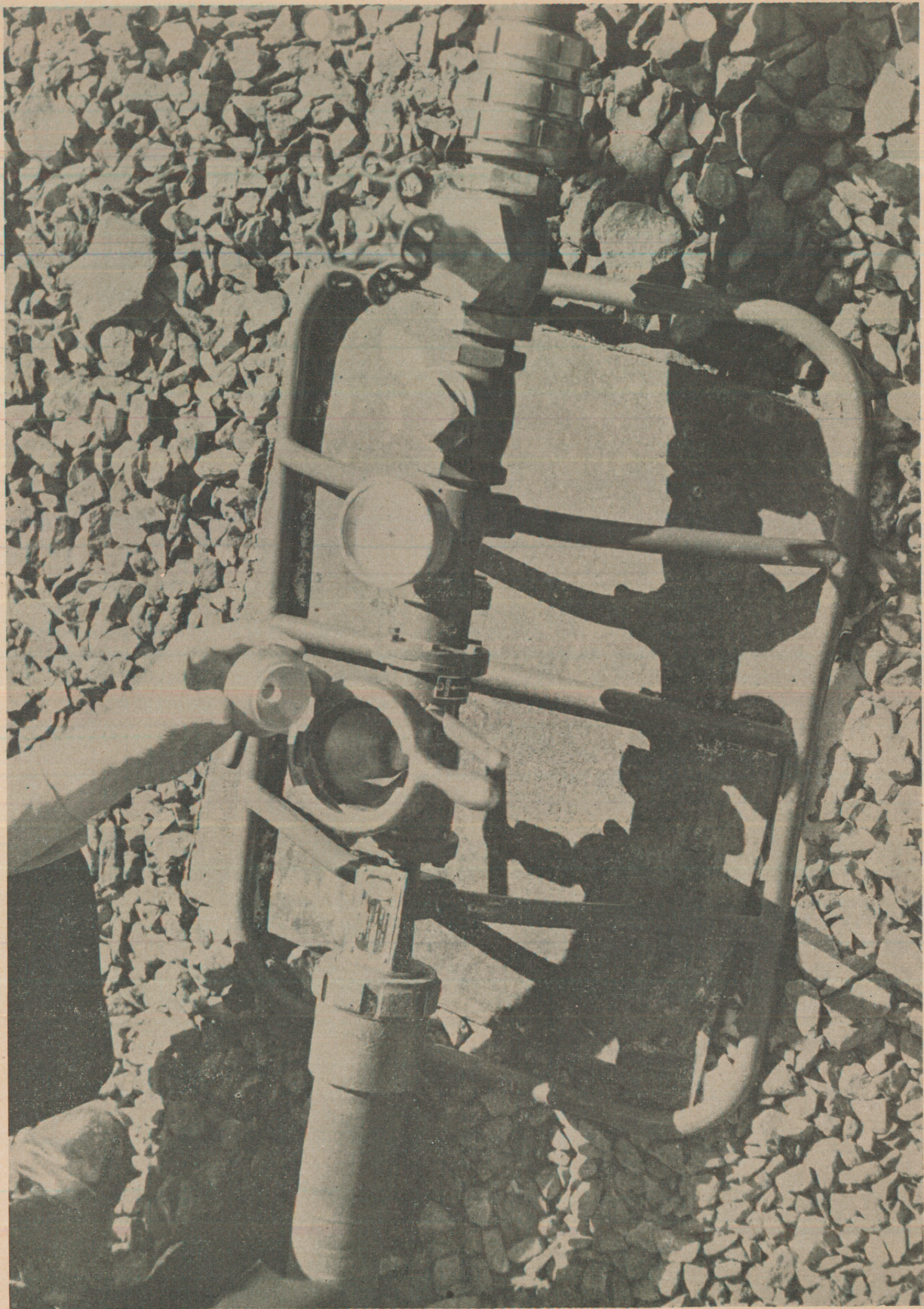


Figure 19—Incendiary Mixer Mark 1 Mod 1 — 7/16" diameter Napalm orifice before insertion into throat of suction chamber. Restriction is necessary when using Navy Type 1 Napalm.

restrict the flow of Type 1 Napalm. A kit will be provided later to change over the mixers Mk 1 Mod 0 in the field to the Mk 1 Mod 1 type.

The Napalm shut-off valve (See Fig. 21) should be opened *after* the gasoline starts flowing and closed *before* the gasoline stops flowing. This procedure keeps the hopper and suction chamber dry and avoids back splash. A clean-out plunger (See Fig. 22) is provided on one side of the mixer body, to remove any gel which may be bridging or plugging the opening in the Napalm shut-off valve. It is usually essential and always advisable that this plunger be used in each mixing operation. The plunger should be operated while the Napalm shut-off valve is closed and the gasoline is still flowing. This procedure will permit the stream of gasoline to carry away any plug (gel) removed from the valve opening. The Napalm shut-off valve will leak if not properly lubricated with a gasoline-insoluble grease (Merco-Nordstrom 357 or equal). The grease is applied through the fitting (See Fig. 17) provided underneath this valve. Proper lubrication can be readily checked by observing if there is any leakage while the end of the discharge hose (hose filled with gasoline) is raised to a height of about 15'.

It may be necessary to repack the throttle valve occasionally to prevent its leaking after prolonged contact with gasoline. The packing used in this valve can be improved by greasing with a gasoline-insoluble grease.

The adjustable nozzle (See Fig. 18) is provided with calibrations ranging from 1, the smallest opening, to 6, the largest opening. The approximately correct setting of the adjustable nozzle for an intake of 6% U. S. Navy Napalm Thickener Type 1 is usually 4. Settings below 3½ are quite sensitive, and settings below 1½ eliminate suction and cause gasoline to rise into the hopper; hence, the latter settings are never used during mixing operations.

(2) Modification

Thickeners other than U. S. Navy Napalm Thickener Type 1 which are slow-setting, can be successfully mixed with gasoline by providing air agitation while loading the droppable

tank with Incendiary Mixer Mk 1 and Mods. This method is not recommended, however, because the compressed air may contain damaging amounts of water, and because of the creation of excessive gasoline fumes and possibly static electricity—a dangerous combination even though rigorous safety measures are practiced.

8. FIELD METHOD FOR MIXING AND TRANSFER OF GASOLINE NAPALM MIX

A. General

NOTE: U. S. Navy Napalm Thickener Type 1 is not recommended for use in the following field method of mixing, because it would be virtually impossible to disperse this quick-setting Napalm fast enough to obtain a homogeneous mixture.

There has been developed a system of mixing the gasoline Napalm mix, which has proved satisfactory for land base use. However, the mixing process presents a serious fire hazard because gasoline vapor is given off during the mixing process. In addition, this method has the drawback of requiring 4 hours for curing after the agents are mixed. Because of these factors the field method of mixing is not suitable for use aboard carriers.

B. Field Method of Mixing and Transferring

Using any available facilities for dispensing gasoline, measure 40 gallons of gasoline into a 55 gallon drum. As mentioned previously, standard 80 octane gasoline or 100 octane gasoline can be used.

Weigh a total of 21 pounds of Napalm. Place a funnel in the 2" opening of the drum.

Next, insert an air agitation tube from an air compressor into the ¾" opening in the drum and permit a rapid but quiet bubbling of the gasoline. Pour the 21 pounds of Napalm into the funnel as rapidly as possible, shaking the funnel. (If the Napalm is blown back into the funnel, reduce the quantity of air.) When all the Napalm is in the drum, move the air agitation tube back and forth across the bottom for about 4 minutes to whip into the solution any Napalm which may have settled.

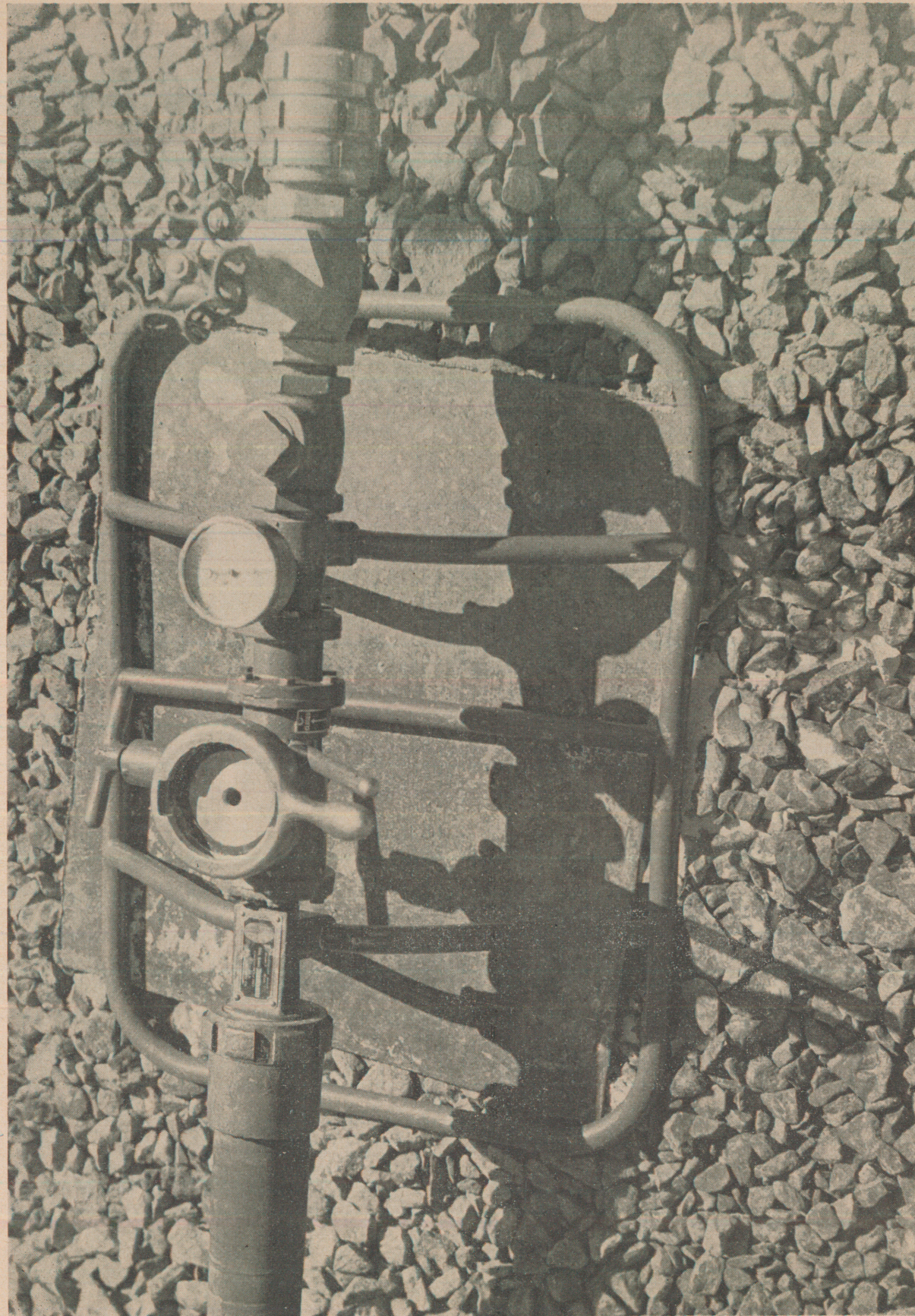


Figure 20—Incendiary Mixer Mark 1 Mod 1—7/16" diameter Napalm orifice after insertion into throat of suction chamber.

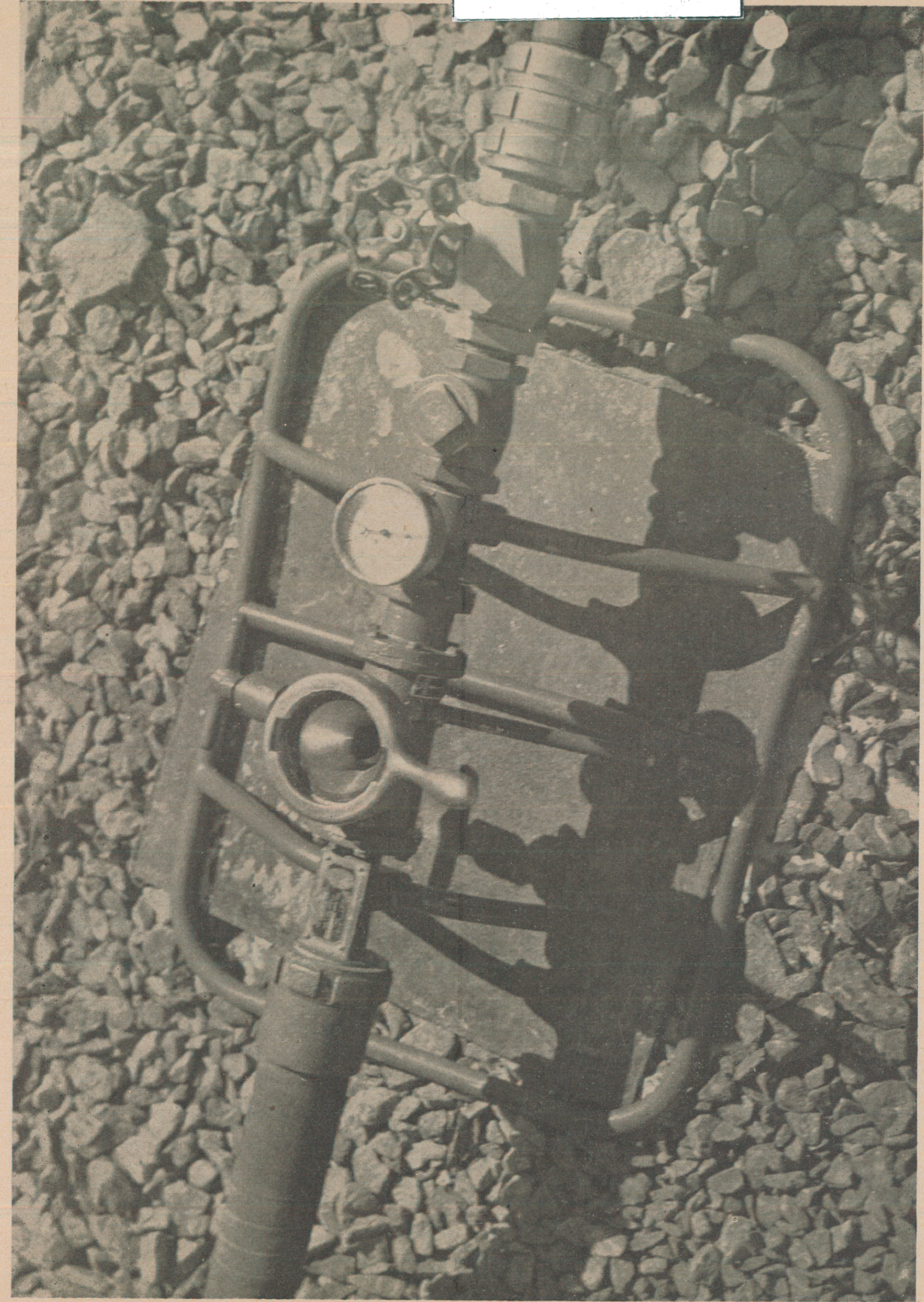


Figure 21—Incendiary Mixer Mark 1 Mod 1. Napalm shut-off valve is only three-fourths open. In actual use the valve must be either fully opened or fully closed.

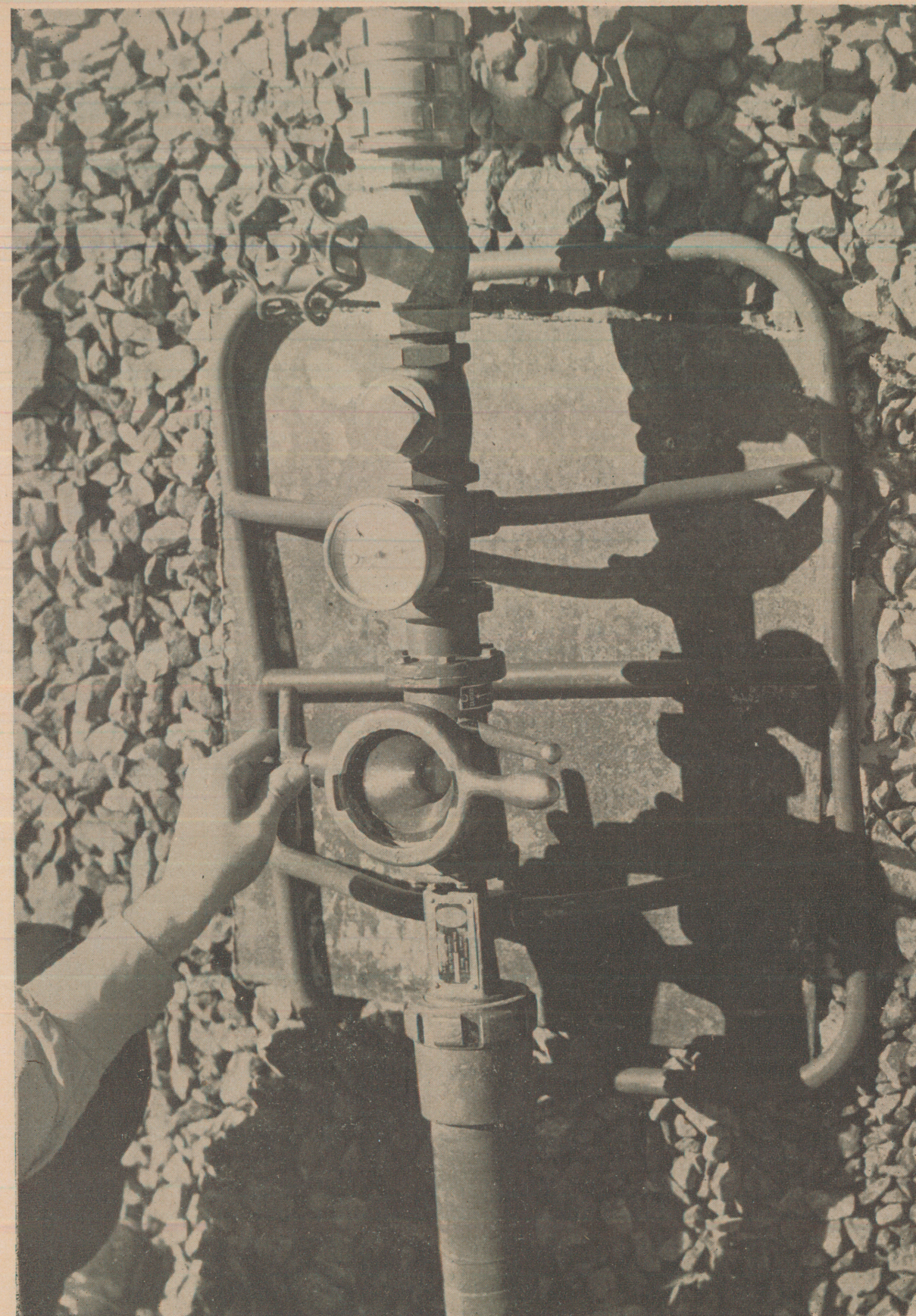


Figure 22—Incendiary Mixer Mark 1 Mod 1 — Clean-out plunger depressed. Note that Napalm shut-off valve is closed when operating.

When the Napalm starts to dissolve, add 13 gallons of gasoline and agitate gently for about 1 minute, or until all the Napalm is completely suspended. (Do not blow air through the mix any longer than necessary, as this promotes evaporation resulting in a loss of gasoline, increase of gas fumes in the air, and chilling of the mix. (Chilling increases mixing time required.)

When agitation is complete, replace the bungs and invert the drum to reduce caking of Napalm on the bottom of the drum. Store in this position for at least four hours to "cure" the mix. This period of curing is necessary to permit the Napalm and gasoline to become an homogeneous mixture. (Once mixed, the fuel may be left in the drums for extended periods without "breaking down" occurring.)

Transfer of the gasoline gel from the mixing drum to the droppable fuel tank is accomplished by compressed air. A 2" hose, fitted with an adapter, is connected to the large size opening of the drum, while a hose from an air compressor is attached to the small $\frac{3}{4}$ " hole of the drum. See Figure 23. A pressure of 15 p.s.i. is sufficient to empty a drum in 6 minutes through approximately 14 feet of hose and a quick opening valve into the fire bomb.

(Pressure should not exceed 40 p.s.i.)

Three 55 gal. drums of the gasoline gel must be prepared for each 165 gallon droppable fuel tank.

Caution must be observed throughout the mixing procedure. Spilled gasoline constitutes a considerable fire hazard, and the thickened gasoline dries to a hard coating, requiring scraping to remove. Therefore, upon completion of filling operations, filling equipment should be drained thoroughly and flushed with gasoline.

9. SHIPBOARD STOWAGE

A. Napalm Thickener

It is recommended that separate stowage be provided for Napalm in any space which is not fitted out as a magazine. For purposes of expediting mixing of Napalm with gasoline, it is recommended that the Napalm be stowed in a locker or compartment on the gallery or main deck level in aircraft carriers. Tests recently performed indicate that Napalm powder will start melting to a gel-like substance at temperatures between 230°F. and 248°F. It is believed that existing shipboard fire fighting facilities are ample to control any fires in Napalm

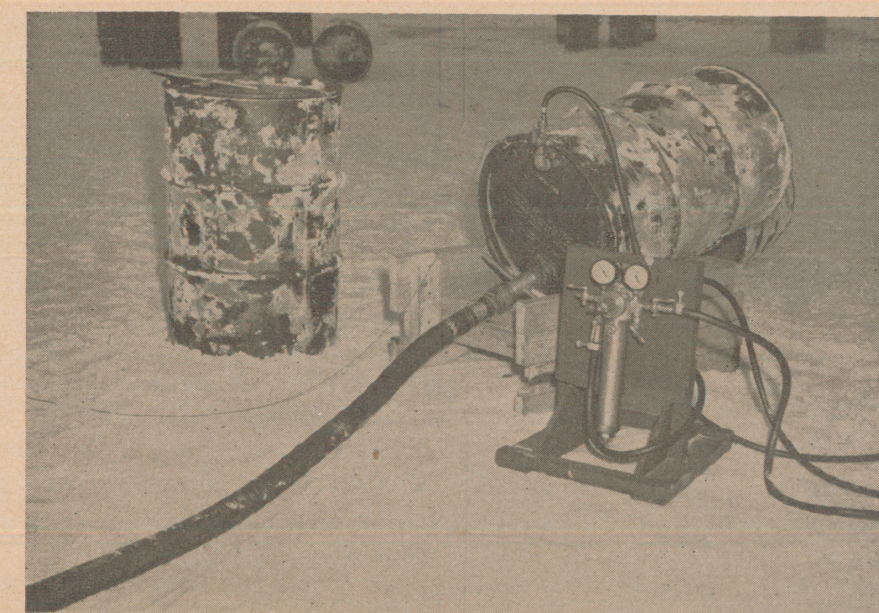


Figure 23—Multiple take-off assembly and feed line connections from gel-filled drum to tank.

powder. However, it is recommended that sprinkling systems be provided in compartments in which Napalm will be stowed in order to keep the temperature of Napalm below the melting point in case of fire in the compartment or in adjacent compartments.

B. Igniters

Sodium (Na) igniters should not be stowed in the same or adjacent compartments to those in which white phosphorous (WP) igniters are stowed. This is necessary because of the different fire fighting techniques employed in combating sodium and white phosphorous fires. It is therefore recommended that the igniters be stowed in separate lockers in accordance with the requirements specified for chemical ammunition in articles 14C14(e) and 14C15 (b) of the Bureau of Ordnance Manual (1943 edition). Stowage should be topside.

C. Incendiary Mixer Mark 1 and Mods

The Incendiary Mixer Mk 1 and Mods may be stowed in the squadron workshops or store-rooms located on the gallery deck.

10. STOWAGE ASHORE

A. Napalm Thickener

Should be stowed away from readily inflammable material and kept dry. It may be given inert stowage.

Marinco 50-50. May be given inert stowage, but must be kept dry.

B. Igniters

Igniters should be given magazine stowage in accordance with Ordnance Pamphlet No. 5. WP igniters must not be stowed with NA igniters due to the different fire-fighting techniques.

11. SAFETY PRECAUTIONS

A. Napalm Gasoline Mixtures

Safety precautions concerning the handling and stowage of gasoline and the fire fighting equipment and fire fighting techniques currently in use for extinguishing gasoline fire are adequate for fires resulting from the ignition of Napalm gasoline gels.

B. Dry Napalm Powder

In storing Napalm Thickener such precautions as govern the stowage of ordinary combustible materials should be used. Stowage should be in a cool, dry location. Water fog is the best method of extinguishing a Napalm powder fire. Fog foam, or a foam stream (chemical or mechanical) is likewise effective. CO₂ should not be used unless the fire is small and in its incipient stage and not subject to re-flash from adjacent heated surfaces. Vapors from heated Napalm and from burning Napalm are toxic, therefore rescue breathing apparatus should be worn while working in noticeable concentrations of such vapors.

C. Dry Marinco 50-50

Marinco 50-50 consists of a precipitated Magnesium Calcium Carbonate used as anti-caking agent. It is to be added to Napalms other than Napalm, Navy Type 1, in order to facilitate flow of the Napalm in the hopper of the mixer. It is entirely inert and can be stowed accordingly, except that it must be kept dry.

D. WP Igniters

Fire involving WP loaded igniters should be fought with water, wet sand or carbon dioxide. If air is excluded from White Phosphorous it will not burn. WP may be extinguished permanently with a five per cent solution of copper sulfate in water.

E. Sodium (Na) Igniters

Water must never be used on burning sodium or on burning buildings or equipment in which sodium is stored or used. Dry soda-ash, dry graphite, or dry sand will quickly smother sodium fires. Chemical solution type, vaporizing liquid type, or carbon-dioxide extinguishers are not effective and their use will add to the hazard instead of reducing it. The chemical solution type of extinguisher (soda acid) contains water, while the vaporizing liquid type (carbon-tetrachloride) and carbon-dioxide both react violently with sodium.

The fumes of burning sodium are essentially caustic and hence irritating. An approved type respirator should always be available and

men should always put the respirator on before attempting to fight a sodium fire.

The residue from burned sodium must be handled with care since it is caustic. Goggles, face masks, rubber gloves and aprons should be worn in handling it.

Immediate first-aid treatment for sodium burns should consist of neutralizing the so-

dium with a 2% solution of acetic acid or with saturated boric acid solution. Persons burned with sodium should always be required to report to sick bay for treatment. This same treatment should be used for burns suffered from the caustic residue of burned sodium, after the skin surface has first been thoroughly flushed with water.